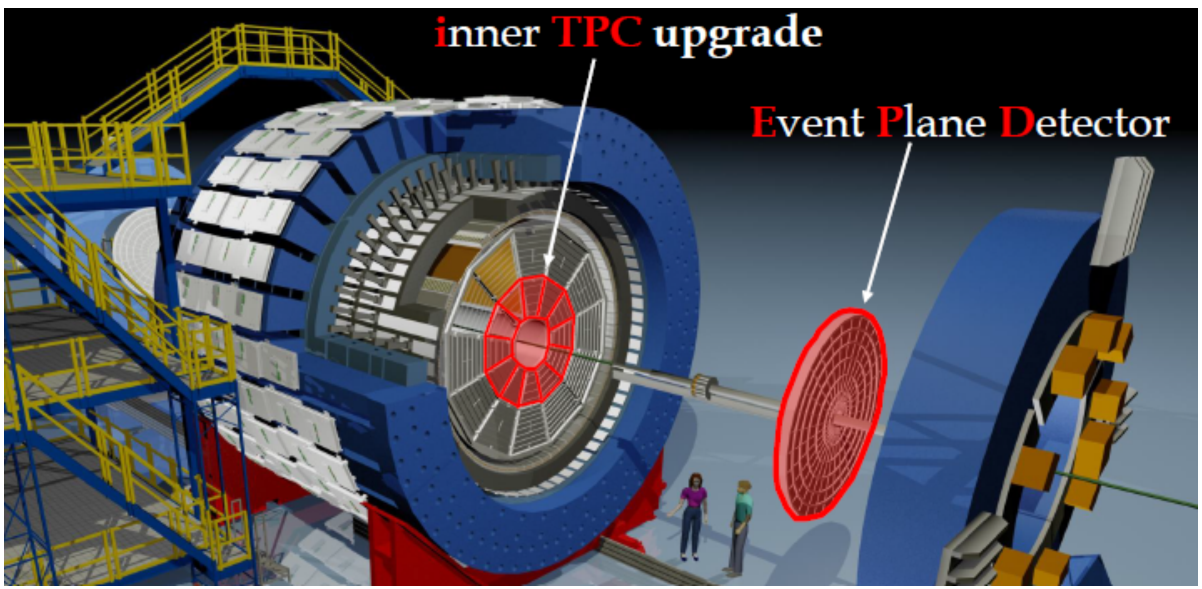
Schedule, Cost , Management, KPP, Risks

Flemming Videbæk
BNL



Overview

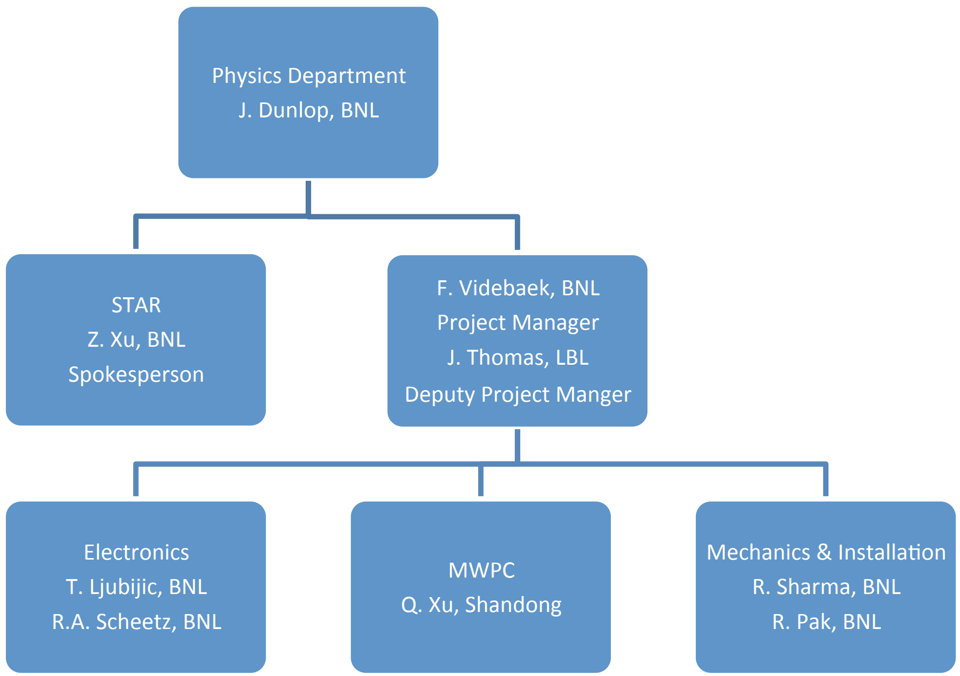
- Management
- Cost & Schedule
- ES&H
- Risks
- KPP
- Issues, and Concerns
- Testing, commissioning
- Summary

The Team, Organization

- Mgt: J.Thomas, F.Videbaek, Z.Xu
- Integration,Installation R.Sharma, (STSG) R.Pak (Liasssion Phycist) W.Christie (CA-D)
- Electronics T.Ljubicic, R.Scheetz, S.Valentino (STSG)
- Padplane joining/Procedures LBNL (Eric Anderssen,LBNL)
- MWPC Qinghua Xu (China)

Org Chart

- Org Chart, institutions



Institutions

Brookhaven National Laboratory - BNL	Mgt., electronics, installation, testing
Czech Technical University in Prague - CTU	physics
Kent State University - KSU	physics
Lawrence Berkeley National Laboratory - LBNL	Mgt., assembly
Nuclear Physics Institute, Academy of Sciences	physics
Shandong University, China - SDU	MWPC construction
Shanghai Institute of Applied Physics SINAP	physics and calibration
University of California at Davis UCD	physics
University of Science and Technology of China USTC	MWPC testing

Reporting & Communication

- High Level
  - The Project will provide quarterly reports with the sub-system managers to BNL management and will have a phone conference with the DOE NP office
  - Annual progress reviews with outside experts will be conducted by DOE.
- **Weekly**
  - iTPC group (Management issues, progress reports)
  - Electronics sub-system mgr participates in ALICE SAMPA weekly meetings
  - iTPC group members joins the STAR TPC group meetings
- **Biweekly**
  - Installation and integration meetings
    - Members from iTPC and STAR operations group.
- **As often as needed**

  \- Management team will conduct design reviews and technical progress reviews on a regular basis

Key ingredients for Upgrade

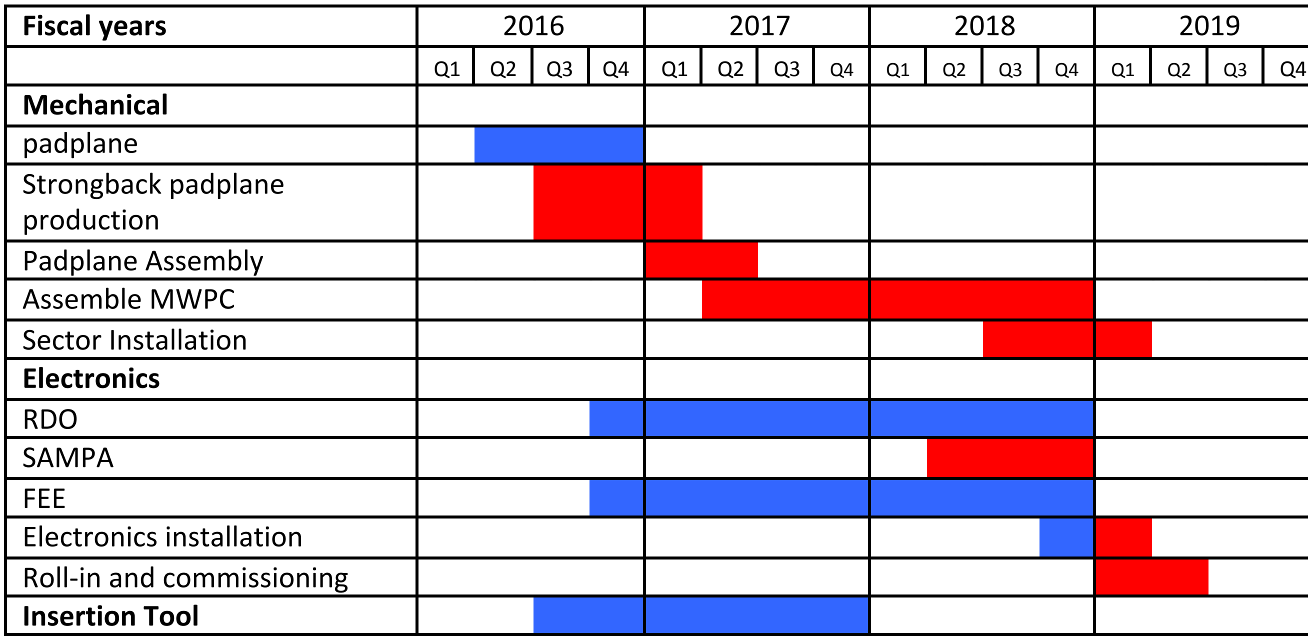
- 24 Inner sectors Strong backs
  - Pad planes
  - Padplane Joining
  - Multi Wire Proportional Chamber (MWPC) assembly
- Readout Electronics
  - iFEE using SAMPA chips
  - iRDO
- Installation Insertion Tooling

Schedule

- Schedule drivers
- Overview and discussion of schedule
  - Additional info was presented in earlier talks
- Run-18 discussion
  - CeC and LEReC commisioning
- Installation activities and schedule

Summary Schedule

- The WBS schedule has about 150 tasks



Current schedule has STAR ready for data taking March 1 2019, with ~1.5 month of commissioning. Single sector tested in run-18 Key goal of project is to have upgrade complete for Run-19.
Critical path goes through electronics path a) (SAMPA chip)
b) sector production installation, and testing, commissioning

Discussion of schedule

- Padplanes
  - Design was finalized in February
  - Pre-production complete 8/24/16
    - Significant production issues
  - Production Padplane complete (12/16/16)
- Strongbacks
  - Final models and drawings finalized (1/30/2016)
  - All strong backs produced and accepted
- Pad plane bonding
  - Contract and agreement with LBNL management has been setup, funds are available at LBNL. Due to the late delivery of pad planes to LBNL the production rate will be slower than anticipated.Once the first of padplanes have been delivered to SDU this is no longer a schedule risk.

MWPC schedule

- Assembly with MWPC is a long process ~15 days per sector with a long overall production time. This is a estimate from our group and consistent with initial STAR assembly before RHIC startup.
- Prototyping and practicing methods on going
- Start MWPC Assembly March 2017
- Last Modules at BNL by October 2018
  - Will be tested at SDU, and retested following the shipping to BNL
  - It is possible that the assembly time can be shortened; Experience at SDU and likely use of glue with shorted curing time. Precise schedule really depends on sector assembly process.
  - Still need to gain experience with testing time needed.

Electronics Schedule

Development of RDO and FEE 2016-2018

Production of RDO complete 10/2018

Production of FEE w/o SAMPA complete 10/2018

The electronics schedules has several external drivers:

- SAMPA prototype chip (available, retired risk)
- SAMPA production (discussion in previous talk)

The schedule takes into account the planned dates, as they are currently known from the ALICE developers.

FEE complete w SAMPA 11/2018

Installation

- After STAR is rolled out the TPC end wheels has to be stripped of services, insertion tooling needs testing. Responsibility of STSG
- After run-17 STAR will be rolled out with the goal of replacing on outer sector with existing spare, and install one completed iTPC sector
- The run-18 scheduled is not currently settled. In early discussion with CA-D a time period of Feb-April (13 cryo weeks) was viewed as an option.
- The estimated time needed to roll–in/out, out and replacement of all inner sectors, and checking, commissioning is estimated to be 10 month.
- The installation of a few sectors before run-18 will give us experience by establishing procedures and providing better time estimate. At this point do not take credit for possible shorter installation time.

Key Milestones

For this review the schedule was updated to reflect the actual status of production.

In particular the pad plane production has had issues, and delayed.

Mechanical		
	Pad plane PCB finalized	2/22/2016 (A)
	Pre-production pad plane complete	8/24/2016 (A)
	Strongback drawings finalized	1/28/2016 (A)
	Padplane production complete	12/16/2016
	First strongback ready for inspection	6/3/2016 (A)
	Strongback production complete	7/20/2016 (A)
	First strongbacks joined and shipped	1/30/2017
	MWPC production assembly starts	3/1/2017
	First 2 sectors at BNL	9/6/2017
	Last 6 sectors at BNL	10/3/2018
	Sector testing complete on floor	10/31/2018
Electronics		
	Receive SAMPA prototype	9/19/2016
	Prototype FEE ready for test in run-17	1/15/2017
	FEE preproduction complete	10/30/2017
	FEE production starts	6/12//2018
	RDO prototype complete	11/11/2016
	RDO final design signoff	6/25/2018
	RDO production complete	10/29/2018
	FEE assembled with SAMPA and ready for installation	10/25/2018
Installation		
	Start work of STAR detector in Assembly Hall after run-17	6/16/2017
	Insertion tooling tested and 1 sector replaced	11/3/2017
	Start sector Installation	5/16/18
	East installation complete	9/19/18
	West Sectors installation complete	12/12/2018
	Electronics complete Installed	1/30/2019
	Full system commissioning Complete	3/27/2019

+4 mo.

Cost

- The cost estimates are based on experience with production of the original STAR TPC, DAQ1000, prototyping of electronics components (FEE,RDO).
- Costs for strong backs, pad planes known. SOW from LBNL covers padplane joining.

Cost to DOE

		FY16	FY17	FY18	Contingency	Total
Mgt	1.1	54	92	94	45	285
Padplane	1.2	105	0	0	17	122
Mechanics	1.3	865	264	15	238	1381
Installation	1.4	0.0	0.0	136	31	168
Electronics	1.5	19	277	1056	296	1648
Total DOE		**1,042**	**632**	**1301**	**628**	**3603**

The NSF China contribution is not included
Cost are in AYk$
Funded by BNL Capital funds with 1.2 M$ for each FY16-18
The insertion tooling is not part of project (ops). Progress being tracked.

Mechanical Cost

Strongbacks
Pad-plane joining
MWPC
  Parts, shipping
  Assembly; part of NSFC project

AY k$

Mechanics	FY16	FY17	FY18	Conting	Total
strongback	315.1	70.0	0.0	87.7	472.9
tooling	16.0	79.0	0.0	18.0	113.0
padplane joining	522.0	47.7	0.0	114.9	684.6
MWPC	13.9	66.8	14.8	18.0	113.5
Total	**867.0**	**263.6**	**14.8**	**238.6**	**1,383.9**

Electronics Cost

Electronics cost evaluated by Tonko Ljubicic & Bob Scheetz.
As mentioned includes spares.
Cost basis with developing prototypes, cost of parts, and experience of electronics group

Electronics	FY16	FY17	FY18	Conting	Total
SAMPA	0.0	253.1	0.0	95.4	348.5
FEE	9.4	4.8	445.5	85.6	545.3
RDO	9.4	4.8	255.8	46.8	316.7
DAQ	0.0	0.0	302.0	55.3	357.2
Integration	18.7	19.2	52.8	13.3	104.0
Total	**37.4**	**281.8**	**1,056.0**	**296.4**	**1,671.7**

US/China connection

Schedule and funding in China

- **6.5M RMB (~1M $) support in total from China for MWPC :**
  - **✓ 2M RMB from MoST 973 key project for high energy nuclear physics (2014-2018)**
  - **✓ 3M RMB from NSFC key project for international cooperation (2016~2020), approved Sep. 2015.**
  - **✓ 1.5 M RMB in-kind contribution from Shandong University.**

Costs to Date (Sept 1)

	WBS	Orig BAC	Current BAC	Cum actuals	Req.
1	Management	218	218	14	0
2	Padplane	105	105	11	5
3	Mechanics	1,145	1,145	191	8+607
4	Installation	136	136	0	0
5	Electronics	1,375	1,375	23	15
	subtotal	**2980**	**2980**	**239**	**635**
	Project Contingency	624	624		
	TPC	3,600	3600		

Will have total cost for strongback, padplane ,prototype, FEE, RDO prototype.
Commitment for LBL 607 k$ – funds transferred to LBNL

ES&H

- The ES&H issues for this project are minor.
- BNL Standards Based Management System (SBMS) provides the basis to identify standards for all equipment, control works, and mitigate hazards.
- The C-AD Experimental Safety Review Committee (ESRC) reviews the equipment and work procedures using the ESRC procedures and the SBMS.

ES&H cont.

- ESRC has experts to review hazards
  - Fire, Gas, HV, electrical,…
  - STAR has Safety Coordinator in the STAR halls
  - The iTPC inner sectors and material wise and construction wise identical to the existing inner sectors.
  - The sector removal and sector insertion will need work planning to protect equipment and personnel.
- The iTPC safety coordinator is Robert Pak

KPP/UPP

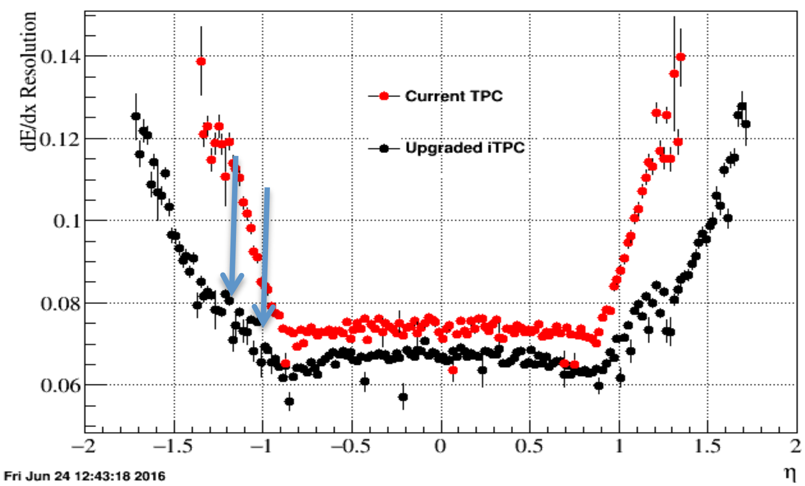
Parameter	Threshold value (KPP)	Ultimate value (UPP)
dE/dx resolution for pions/muons at BES-II energies	-	<6.9% $\|\eta\| \le 0.1$ < 8.0% $1.0 < \|\eta\| \le 1.2$
Gain at Nominal Voltage	~2000 +-5% at 1150 Volts	-
Tension on Anode Wires	0.50 Newtons ± 0.05	-
Fully working sectors delivered to BNL or repairable at BNL	22	-
HV sections operational	>95%	-
Compatible with STAR DAQ-1000 system	< 8%deadtime @ 1kHz and 30% @ 2 kHz from iTPC inner sectors	< 5% @ 1kHz and 20% @ 2 kHz dead time from iTPC at BES-II energies
Operational electronics fraction	Less than 8% dead channels per sector	Less than 3% dead channels for full system
Electronic Noise	< 2 ADC counts	-
Electronics gain Uniformity	<10%	

Goals

- The KPP are defined such that if fulfilled we expect the detector system to have the performance needed to deliver the physics.
- The KPP can be demonstrated ahead of installation of the detector, such that project completion can be ensured.
- The UPP are meant to demonstrate with beam that the requirements are met after e.g. calibrations of dE/dx and cluster finding for the optimal performance.

KPP/UPP

- The resolution of the dE/dx is a critical parameter for the performance of the TPC The upgraded TPC with the inner sectors will provide part of the total dE/dx signal. For $|\eta| > 1$ the inner sectors are the dominating contributor to the dE/dx and considerable better than the current TPC. This can be measured with beam and be demonstrated after several months of calibration work.
- The KPP are measurements that needs to be fulfilled to achieve the performance for the UPP



KPP's

- Gain at Nominal Voltage
  - Determines the signal magnitude; one of the ingredients of the S:N
  - Tested during construction
- Tension on Anode wire
  - Determines the uniformity and one parameter for dE/dx
- Electronics noise and gain uniformity
  - Determines pad response, S:N and dE/dx response
- Working fraction of detector
  - Coverage in rapidity and phi

Risk Analysis

These risk identified here are the major ones identified by the project

There are other risks are currently being moved to a risk registry.

Pad plane

Description:

- The pad plane is a critical component in an inner sector assembly. It must be produced accurately and on time.

Risk:

- There is a possibility that the material used for the pad plane does not meet requirements in terms of tolerance and/or material specifications.

Mitigation:

- The design has been undergoing multiple iterations, and one prototype. The specification has been cross checked to ensure that the mechanics are OK. The material selected will be certified Bromine free. A rigorous QA program will be established and followed, including survey and certified inspection of the final parts.

Joining of padplane and strongback

Description:

- The assembly of the padplane with the strongback is a high precision task that must be kept within tight tolerances. The proper tooling and procedures must be employed, requiring effort in engineering, design and training.

Risk:

- This is a technical risk. If the task is not done with high precision the performance of the TPC could be compromised; particularly in regard to uniformity of gain and the quality of dE/dx measurements.

Mitigation:

- It is envisioned that this work will be done in the LBNL shops since they have the technical capabilities to perform the task. Nearly all procedures have been recovered from the original design documents and oral histories collected from the retired technicians. The technical capabilities at LBNL include access to CMM, survey tools and large milling machines in workshop.

Wire mounting of MWPC planes

Description:

- The task involves wire winding, and mounting the wire planes to the strongbacks. There is a requirement for high precision to achieve proper parameters in terms of wire tension, distance between wires and wire planes to padplane.

Risk:

- If the prescribed accuracy is not reached the performance of the TPC may be compromised. It is very likely that it will function, but the calibration task to get optimal dE/dx resolution will be much more difficult.

Mitigation:

- This task will be done by the collaborators at Shandong University through a project funded by the NSFC in 2015. As part of this activity, they are developing procedures and making measurement on prototype MWPC planes. A number of tools, fixtures, and apparatuses were designed to check and maintain the required precision. For example a laser based wire tension measurement system has been designed to measure the wire tension for each wire and can also check the wire pitch. It is envisioned that one more round of prototyping will be done. The extensive prototyping work at Shandong reduces the risk involved in this task.

Electronics

Description:

- The electronics has been developed in an R&D phase by the BNL STAR electronics group, and most components have low risk at this point. The electronics is based on the SAMPA chip being developed for the ALICE TPC upgrade.

Risk:

- Even though the iTPC group is involved in the regular meeting on the SAMPA chip *developers*, we cannot control the schedule thus leading to a high risk for schedule of delivery of the chips. There is also a risk in terms of having funds available for procurement in a timely fashion. Manpower levels for the electronics engineering effort are sufficient at this time, but a loss of future manpower would be a serious problem for the project.

Mitigation:

- The first prototype SAMPA chip, with all 32 channels and sufficient functionality for STAR, is about to be submitted and should be available in April 2016. STAR does not need all the functionality that ALICE requires, and the risk can be mitigated by negotiating with ALICE that a relatively small production run gets agreed upon, early, and before the main production run for the ALICE TPC upgrade.

Installation

Description:

- The new sectors and the inside of the TPC must be kept in a clean environment during installation. The assembly will be with STAR rolled out of the IR into the assembly hall.

Risk:

- If the inside of the TPC field cage is contaminated during the installation with debris, or dust, then there is a risk for reduced performance of the TPC and possibly not being able to hold full voltage on the Cathode Plane or degraded tracking performance due to electrons lost or attenuated by contaminated gas.

Mitigation:

- The risk will be mitigated through engineering controls and design of a clean enclosure around the end caps during installation, thorough cleaning of the assembly area, and administrative procedures for access to the work area.

QA

- Recouped knowledge and procedures from original production
- Have recovered previous QA procedures for production of sectors including MWPC, and for testing of assembled sectors
- Generated new travelers (dual language)
  - See Qinghua's talk
- The testing plan for assembled sectors both in China and the tests needed after being received at BNL, before installation is being designed;
- It includes but not limited to
  - Wire tension measurements
  - HV burn in
  - Gain test with sources
  - Response test with X-ray
  - Check for broken wires
  - Cosmic ray tests

Testing and Commissioning

- Electronics testing
  - A few FEEs installed on STAR for run-17
  - Single sector with new electronics (full or partial) for run-18. If (electronics or sector) not available in time for run sector test outside STAR. Partial system test – for DAQ, sector response and operation.
- Commissioning after installation
  - Start readout/DAQ commissioning on one side while other side of TPC being installed.
  - Continue before and after roll in and until beam start
  - Plan on 1 week of cosmic data taking
- Note: the length of commissioning period determines the start of run-19

Critical Issues

- Start of MWPC production
  - The delayed procurement of padplanes implies this will start ~ March 2017
- Schedule
  - The overall schedule is tight. With installation squeezed between two RHIC runs the commissioning time is under pressure if there are delays in sector production
- Production schedule of SAMPA chips
  - The production may slip
    - Important to ensure that STAR can get enough chips from the MWPC3 and engineering run

Summary

- Made considerable technical progress since the directors review
  - Production of strongbacks were completed
  - Prototype pad planes have (finally) been produced to specifications
  - Successful first implementation of prototype iFEE with SAMPA chip functionality.
- Prototype MWPC assembly ongoing at Shandong
  - Demonstrates that sufficient expertise and resources are available.
- Identified the significant risks
  - SAMPA chip delivery on time – might impact run-19
  - Schedule for assembly of strong backs
  - Production quality of strongbacks
  - Installation of completed sectors
- It is a challenging project with limited commissioning period, driven by the yearly RHIC running schedule with a run-18 and run-19, and the long installation time

BACKUPs

Response to Jan. review

- Physics impact for a shortened run-19
  - Move 11.5 GeV to run-20
  - Start run-20 in November 2019 for longer run
- Instrumentation strategy for using the old TPC electronics in FY19
  - The pad plane connector layout was re-designed to accommodate same #pad for even/odd pad rows
  - Allows current electronics to be used for early testing
  - Allows if SAMPA chips are late to use current electronics for a run-19
  - There is a loss in physics – the performance with 20 padrows is not as good as with 40 in the inner sector, but a slight improvement over current 13.

Risk comments

- There are definite options to retire some risks early. E.g. It is likely that first sectors will be a BNL during late 2017, and initial installation can then start and proper experience gained for the later part of the installation where schedule that is tight.
- January 2018 will be a key decision point. The SAMPA chips are supposed to be submitted – if that happens the FEE schedule is very likely to hold, otherwise the alternate electronics plans devised can be set in motion.
- Likewise the sector schedule and performance will be understood better at that point

Backup – 20 vs. 13 padrows